Growth and Quality of

PRUNED BLACK WALNUT

F. BRYAN CLARK
KENNETH W. SEIDEL

U. S. DEPARTMENT OF AGRICULTURE · FOREST SERVICE
Central States Forest Experiment Station, Columbus, Ohio
Technical Paper 180, July 1961

THE AUTHORS

F. BRYAN CLARK has authored 20 publications since joining the Central States staff in 1949. His first assignment, at Columbia, Missouri, included strip-mine reclamation research in Missouri, Kansas, and Oklahoma. From Columbia he went to Berea, Kentucky and then to Indiana where he is now Senior Project Leader at our Bedford field office. A native Hoosier, Clark received a B.S. degree from Purdue University and an M.S. from the University of Missouri. During World War II he spent about two years in the Pacific Theater with the Air Corps. He is a member of the Society of American Foresters and is presently Chairman of Central States Section.

KENNETH W. SEIDEL began his Forest Service career the summer of 1957 when, as a senior forestry student, he worked at the Central States Berea (Kentucky) field office. After receiving his bachelor's degree from the University of Michigan in 1958, he returned to Berea until his transfer to Columbia (Missouri) field office in January 1959. Ken is a native of Milwaukee, Wisconsin and served with the Army Engineers in Korea during 1953 and 1954. He is a member of Xi Sigma Pi, forestry honorary society, and the Society of American Foresters.

Central States Forest Experiment Station, U.S. Dept. of Agriculture
Forest Service, 111 Old Federal Building, Columbus 15, Ohio

R. D. Lane, Director

Growth and Quality of

PRUNED BLACK WALNUT

by F. BRYAN CLARK
KENNETH W. SEIDEL

The walnut industry has long felt the need for some measures to insure better veneer logs for the future. Black walnut (*Juglans nigra* L.) is our most expensive native wood per unit of volume in regular markets. For this reason the potential returns from investments in pruning should be greater for black walnut than for any other hardwood species. With this in mind a cooperative study[1] was made in southeast Kansas to find out if pruning can improve the quality of planted black walnut.

Ten-year results clearly show that as much as 75 percent of the live crown of walnut can be removed without seriously affecting diameter or height growth. However, sprouting on the cleared bole limits the amount of crown that can be removed at one time.

THE STUDY

The study area is a part of 2,000 acres of pure black walnut plantings located in southeastern Kansas on partially graded coal strip-mined land. The plantation was established in the winter of 1935-1936 by the Civilian Conservation Corps with locally collected seed.

The stand was 14 years old when the study began. At that time growth had been adequate but tree quality was poor due to persistent lower branches (fig. 1). The stands contained 300 to 600 trees per acre averaging about 4 inches in diameter at breast height. Average height of dominant and codominant trees was 25 feet.

---

[1]The study was made in cooperation with the American Walnut Manufacturers' Association and the Kansas Forestry, Fish, and Game Commission.

Figure 1. — This tree will produce poor-quality wood for many years if it is not pruned.

Pruning treatments removed 25, 50, and 75 percent of the live crown and as a control, some trees were not pruned. A preliminary examination showed that the leaf area on branches ½ inch in diameter is fairly constant. To estimate the amount of live crown to be removed, all the ½-inch branches were counted on each tree and the percent of these branches corresponding to the assigned pruning intensity was removed. Trees meeting minimum quality standards were selected from the 3-, 4-, and 5-inch d.b.h. classes, so there were 12 different pruning-intensity/d.b.h. classes. Thirty trees on each of two areas were selected for each class, a total of 720 trees.

When the study began, clear length averaged only 2 feet and the height to live crown 5.5 feet. In contrast, clear length after pruning averaged 9 feet for the trees pruned 25 percent, 11 feet for the 50-percent-pruned trees, and 14 feet for the 75-percent-pruned trees. Pruning was done with a handsaw and a 12-foot pole saw. Pruning time increased directly with cleared height[2]. So under the conditions studied, pruning time should not limit the height of pruning up to 18 feet.

Trees were remeasured 2, 5, and 10 years after pruning. Diameter was measured to the nearest 0.05 inch with a tape at permanently marked points at breast height and at 9 feet, the latter to find out if pruning affects bole form. Height measurements were taken with a sectional pole to the nearest 0.1 foot. Growing conditions were good for the first 2 years but several of the following years were extremely dry. A few trees died during the 10-year period and many were so badly damaged by sunscald that 20 percent of the trees could not be used in the 10-year-data summary.

---

[2]Clark, F. Bryan. Time required to prune black walnut trees. U. S. Dept. Agr., Forest Serv., Cent. States Forest Expt. Sta. Note 78, 2 pp., illus. 1953.

GROWTH VARIED BY PERIODS

Diameter growth at breast height and at 9 feet and total height growth for the 10-year period were the same for pruned and unpruned trees. Surprisingly, growth for the 2- and 5-year periods was best on pruned trees. Most information available on pruning is for conifers and shows that growth following live pruning usually slows down for a few years.

Diameter Growth at Breast Height

During the first few years after pruning, trees pruned 50 percent grew fastest — 0.50 inch in d.b.h. in 2 years and 0.80 inch in 5 years. Growth on the unpruned trees was 0.45 and 0.75 inch for these two periods (table 1). Trees in the 75-percent class grew slowest. Diameter growth differences among diameter classes and pruning intensities were statistically significant for the two periods.

TABLE 1. — DIAMETER GROWTH AT BREAST HEIGHT 2, 5, AND 10 YEARS AFTER PRUNING

(In inches)

By diameter classes

Growth period	D. b. h. class			Average
	3	4	5	
2 years	0.40	0.45	0.50	0.45
5 years	.70	.70	.85	.75
10 years	1.40	1.50	1.70	1.55

By pruning intensities

Growth period	Percent pruning intensity				Average
	0	25	50	75	
2 years	0.45	0.45	0.50	0.40	0.45
5 years	.75	.75	.80	.70	.75
10 years	1.55	1.50	1.55	1.50	1.55

After 10 years, differences in growth among pruning intensities were no longer statistically significant. Trees pruned 75 percent had grown slowest but actual differences among means of pruning intensities were very small. Total d.b.h. growth averaged 1.55 inches for all treatments and trees in the 5-inch class grew best for the entire period. The effect of drought between the second and fifth years after pruning is reflected in a reduced growth rate. Undoubtedly the growth from the fifth to tenth year also reflects reduced growth due to drought.

Diameter Growth at 9 Feet

Diameter at 9 feet was measured to find out if pruning changes bole form. At 2 and 5 years after pruning, trees pruned 50 percent grew 0.1 inch more than unpruned trees (table 2). But there were no significant differences among pruning intensities after 10 years' growth. So pruning had no effect on bole form. Diameter growth at 9 feet averaged 0.20 inch more than d.b.h. growth in 10 years. Thus bole form is improving naturally in the stands.

TABLE 2. — DIAMETER GROWTH AT 9 FEET 2, 5, AND 10 YEARS AFTER PRUNING
(*In inches*)

By diameter classes

Growth period	D. b. h. class			Average
	3	4	5	
2 years	0.45	0.50	0.65	0.55
5 years	.80	.85	1.00	.90
10 years	1.60	1.70	1.95	1.75

By pruning intensities

Growth period	Percent pruning intensity				Average
	0	25	50	75	
2 years	0.50	0.55	0.60	0.55	0.55
5 years	.85	.85	.95	.90	.90
10 years	1.75	1.75	1.85	1.75	1.75

Height Growth

Trees pruned the most grew the most in height the first 2 years. Although actual differences were small, they were significant at 5 percent (table 3). However, for 10 years, height growth was the same for all pruned and unpruned trees.

Total height growth averaged 3.5 feet for the first 2-year period. But during the next 3 years growth slowed down and the 5-year growth was 5.0 feet. For the entire 10-year period height growth averaged only 8 feet. During the 2- and 5-year growth periods there were no significant differences in height growth by diameter classes but there was a significant difference at the 1-percent level for the 10-year period. The 3-inch trees grew a little taller than the 4- and 5-inch trees but there was little practical difference. When the 10-year remeasurement was made it was apparent that many of the small trees were growing faster in height than the larger trees. Small trees grew in the dense parts of the stand and had small, narrow crowns. Conversely, large trees had large spreading crowns and shoot growth was put on many leaders.

TABLE 3. — HEIGHT GROWTH 2, 5, AND 10 YEARS AFTER PRUNING
(In feet)

By diameter classes

Growth period	D. b. h. class			Average
	3	4	5	
2 years	3.4	3.4	3.7	3.5
5 years	5.0	4.9	5.0	5.0
10 years	8.4	7.7	7.8	8.0

By pruning intensities

Growth period	Percent pruning intensity				Average
	0	25	50	75	
2 years	3.2	3.3	3.6	3.7	3.5
5 years	4.8	4.8	5.1	5.2	5.0
10 years	8.0	8.0	8.0	8.0	8.0

BOLE SPROUTS RELATED TO SEVERAL FACTORS

Live pruning alters the physiological balance within a tree. Pruned broadleaf species commonly produce new shoots or sprouts and profuse sprouting on cleared boles can cancel out an investment in pruning. Bole sprouts were found to be a serious problem in pruning black walnut.

Sprouting was directly related to pruning intensity. Two years after pruning more than half of the trees pruned 75 percent had bole sprouts but only 6 percent of the trees pruned 25 percent had sprouts. At 5 years, 47 percent of all trees had one or more sprouts; and at 10 years, 56 percent of the trees had sprouts. While none of the unpruned trees sprouted during the first 2-year period, nearly 50 percent of the unpruned trees had sprouts at 10 years. Much of the late sprouting was clearly related to climate and not pruning.

Sprouting was not strongly related to tree diameter or crown class. A few sprouts grew vigorously (fig. 2) but most grew slowly or died. Dead sprouts persisted for several years. Sprouts occurred more often on the west and south sides than on the east and north sides of the trees. And trees growing in the open sprouted more than trees growing in dense shade. Sprouts usually occurred near pruning wounds and originated from dormant buds. Details on sprouting are found in an earlier publication[3].

Early in the 1953 growing season, half of the trees sprouting were repruned. By the tenth year after pruning, three-fourths of these trees had resprouted. But results of this repruning are inconclusive due to the severe climatic effects.

Sprouting may not be so prolific within the optimum range of black walnut. Veneer buyers recognize a degrade in walnut called pin knots. Pin knots are dormant bud traces and are said to be more abundant in logs from eastern Kansas and adjacent areas.

PRUNING NO DECAY HAZARD

It was evident at 2 years that wound healing was rapid and by the fifth year many of the wounds had closed (fig. 3). At 10 years only a very few wounds remained open and these were on slow-growing trees. Fungi fruiting bodies were found on a few open wounds at 2 and 5 years but these were judged to be superficial sapwood invasions. No heartrot fruiting bodies were found 10 years after pruning. However, few pruning wounds were more than 2 inches in diameter and heartwood was rarely exposed. This may partially account for the apparent lack of heartrot, although walnut wood is known to be rot-resistant.

[3]Clark, F. Bryan. Black walnut responds to pruning. Jour. Forestry 53: 362-365, illus. 1955.

Figure 2. — Sprouts on open-grown trees are vigorous.

Figure 3. — After 5 growing seasons this 2.5-inch pruning wound was closed.

Five trees were dissected 10 years after pruning and no evidence of decay was found. Due to the rapid callus growth, clear wood is now forming over many pruning wounds (fig. 4). For large wounds there is still evidence of branch swell in the form of "bulges" in the grain. No bark occlusions were found and all knots were sound.

MORTALITY AND DIEBACK

Mortality was insignificant during the 10 years but about one-fifth of the trees could not be used in the 10-year summary of growth because of crown dieback or severe sunscald on the main stem (fig. 5). Callus growth over injured boles made diameter measurements useless on these trees. Prolific sprouting occurred on trees with injured boles.

Dieback and sunscald were as common on unpruned trees as on pruned trees. Small trees seemed a little more susceptible than large trees. Most of the damage was on the west side of the trees but scalds were noted on all sides. The injuries appeared to have occurred at one time, probably between the fifth and sixth years after pruning. The exposed wood of many of the dieback areas contained emergence holes of wood borers.

CONCLUSIONS AND RECOMMENDATIONS

Ten-year results of the study can be used to set up guidelines for pruning black walnut. Although the study was made in pure plantings in southeastern Kansas, basic results should apply elsewhere. Moreover, the physiological effects of pruning on growth should apply equally as well in mixed plantings. Less live pruning will be needed in mixed stands however, due to better natural pruning. The area studied is not within the optimum range of walnut, and growth should be faster east of Kansas. Also, sprouting may not be so common in areas with a milder climate.

As much as 75 percent of the live crown of 3- to 5-inch trees can be removed without seriously retarding the growth of planted walnut. Growth responses due to pruning last only a few years and have no practical importance. Even successive pruning would probably have little effect unless extreme.

The diameter growth rate for the stand studied has been satisfactory compared with other plantations. Since height growth declined rapidly during and after the extended drought, the development of the stands during the next 10 to 15 years should help determine if walnut is suitable for strip-mine planting in Kansas and adjacent areas.

The possibility of sprouting on the cleared stem limits the amount of live crown that can be removed at one time. And this situation is further

Figure 4. — Ten years after pruning clear wood is forming over this wound.

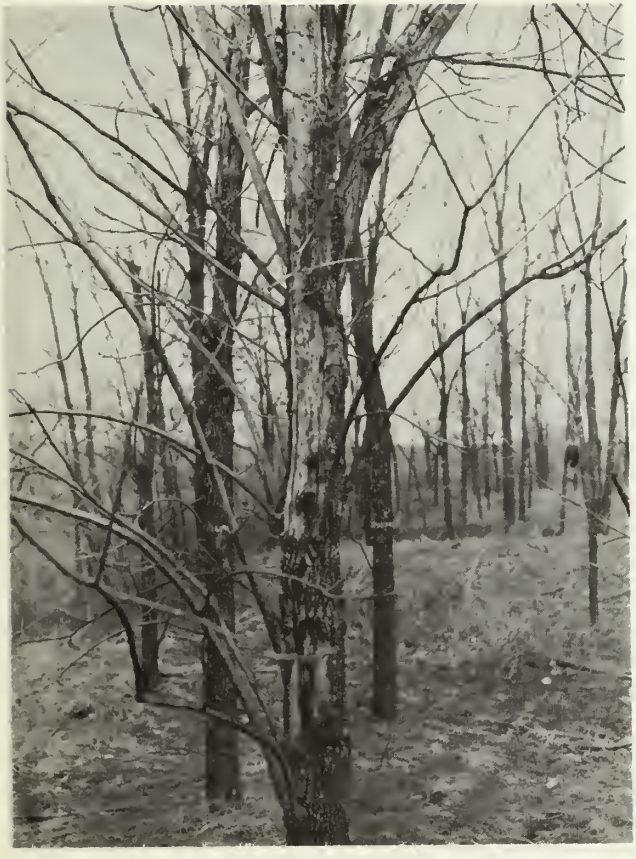

Figure 5. — Sunscald occurred on pruned and unpruned trees alike.

confounded by the location of the individual tree to be pruned. Sprouting was found to be directly related to the amount of light reaching the pruned boles suggesting that the intensity of pruning should be regulated by stand density near the tree to be pruned. Stand density south and west of the tree is more critical than stand density north and east of the tree.

Paradoxically, trees needing pruning most should be pruned least. Open-grown trees should be pruned in stages; no more than 25 percent of the live crown should be removed at one time. If the trees are growing fast, a repruning can be made about 5 years later, again removing dead branches and no more than 25 percent of the live crown. Sprouts can be removed at the same time. Although this procedure is more costly, pruning in stages appears to be the only way to handle open-grown trees.

In denser stands as much as 50 percent of the live crown can be removed at one time (fig. 6). A second pruning 5 to 10 years later will give at least 20 feet of clear length and this should provide good returns at harvest time. In dense stands it may be necessary to remove only dead branches for early clear-wood production.

Figure 6.—Even after half the live crown of this tree was removed sprouting was no problem because the tree was well shaded.

Tree size and crown class must also be considered. Trees should be large enough to be definitely established in the dominant stand. Strong intermediates should be pruned only if released several years before or after pruning. If trees are small when pruned the knotty core will be kept to a minimum. Optimum size is about 3 or 4 inches d.b.h. If trees are much less than 3 inches d.b.h. only a short length of bole can be cleared in one operation. By waiting until trees are 3 inches d.b.h. some of the lower branches will be dead and can be removed without stimulating sprouting. Trees can be too large for pruning for economic clear-wood production. Trees more than 8 inches d.b.h. would have a low-quality core at least 10 inches in diameter. Pruning wounds on such trees would be large and more susceptible to heartrot.

Trees to be pruned should be selected carefully. In planted stands there are many trees that are not worth an investment in pruning. Due to the various factors affecting sprouting, probably not more than 50 to 75 trees per acre should be pruned. Even then all pruned trees cannot be expected to produce veneer logs but the increased value of pruned lumber logs should give good returns.

Pruning is expensive because of the long period that capital is invested. In such a venture it is essential that good growing conditions be maintained through thinnings. To avoid excessive sprouting, stands should not be thinned at the time of pruning. Thinning, weeding, or releasing should be done several years before or after pruning. If a choice is possible, walnut trees should be released on the north and east sides. Thinnings should be light and frequent to obtain maximum silvicultural control.

Unlike most conifers, black walnut is not easy to prune. Trees must be carefully selected and tended. But the price that fine-quality walnut logs command makes this species an aristocrat among hardwoods and special attention at an early age can pay big dividends at harvest time.

The Central States Forest Experiment Station is headquartered at Columbus, Ohio and maintains major field offices at:

Ames, Iowa (in cooperation with Iowa State University)
Athens, Ohio (in cooperation with Ohio University)
Bedford, Indiana
Berea, Kentucky (in cooperation with Berea College)
Carbondale, Illinois (in cooperation with Southern Illinois University)
Columbia, Missouri (in cooperation with the University of Missouri)